THE MODULATING ROLE OF QUESTIONS IN REPEATED ACTION

BY

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THESIS

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Abstract

Repeated action can be more or less under habitual control, depending on how often it has been repeated, how complex it is, and how stable the context is. We propose that in situations where behavior is somewhat habitual but still flexible, repeated action can be modified by self-talk questions: Instead of a direct cue-behavior association, the situation may lead people to ask themselves a question, which then prompts action. Across three studies, participants showed below-baseline rates of behavior repetition when they were presented with the negative question "Which one should I not choose?". In contrast, people tended to repeat their behavior above baseline levels when they were presented with the affirmative question "Which one should I choose?". In Experiment 3, this effect vanished when repetition was explicitly requested, providing evidence for our hypothesis that self-talk most effectively guides behavior when behavior is still flexible.

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Introduction

Imagine you're at a buffet and you have to pick either coffee or tea as a drink. Which one should you choose? If you are a regular coffee drinker, coffee is probably the first response that comes to mind. But what if you asked yourself a different question? Would an unfamiliar question such as "Which one should you not choose?" disrupt your coffee habit? In this thesis, we propose that people naturally ask themselves questions when a choice is required and that these questions can alter established behaviors.

Previous work on repeated action has emphasized an automatic cue-response association. Indeed, an influential definition of habits includes the assertion that "contexts activate habitual responses directly, without the mediation of goal states." (Wood & Neal, 2007, p. 843). It seems self-evident that this is the case for short, well-defined actions that are repeated in a stable setting, such as pulling the brakes while driving or locking the door when one leaves the house. However, many repeated actions in daily life occur in much more variable situations and require variable behavior. Choosing coffee over tea can occur in a friend's home, in a coffee shop, or at a breakfast buffet and the choice may need to be expressed by verbally stating a preference, by pointing to one option, or by reaching for one of the beverages.

Although it seems likely that these varied behaviors happen efficiently, it is unlikely that they are completely fixed patterns cued by the context. This possibility is especially likely when the behaviors occur in varied contexts that are unlikely to share many cues, cue-dependency is unlikely to be completely responsible for stable patterns of behavior. Instead, the environment may prompt implicit verbal utterances that cue the behavior. None of this is new, as previous work states clearly that there is a continuum of habitual control (Neal, Wood, Labrecque, & Lally, 2012; Verplanken & Orbell, 2003; Wood & Rünger, 2016), but in practice the middle area

of this continuum has not received sufficient research attention. The idea of habits developing gradually is also supported by findings from cognitive neuropsychology. During habit acquisition, neural activation shifts from a network that is associated with deliberate control, the associative cortico-basal ganglia loop, to a network that is associated with automatic and efficient behavior, the sensorimotor cortico-basal ganglia loop (Wood & Rünger, 2016; Yin & Knowlton, 2006). There is evidence that this shift does not occur linearly, but instead varies across low, medium, and high levels of habitual control. Tricomi, Balleine, and O'Doherty (2009) trained a group of participants in a self-paced button-press task in 12 sessions that were spaced across three days. They found that task-related activity in regions of the basal ganglia that belong to the sensorimotor loop increased across the training sessions, but not monotonously. Specifically, although on average training effects did carry over across the three days, in the first one or two sessions of each new day participants showed brain activation that suggested a resurgence of goal-directed control. These findings suggest that the degree of habitual control over a behavior can not only increase with practice, but also decrease with factors such as time. Similarly, applied behavioral work has reported resurgences of attentional control and deliberate verbal self-instructions even in highly practiced behaviors (e.g., Geeves, McIlwain, Sutton, & Christensen, 2014; Jenkins, 2007; Toner & Moran, 2014).

Other work has documented the role of automaticity in habitual behavior (Aarts & Dijksterhuis, 2000; Wood & Neal, 2007). Far from contesting the existence of automaticity in habits, we aim to point out that different behaviors at different levels of habitual control may show some, but not all features of automaticity (Bargh, 1994; Moors & Houwer, 2006; Shiffrin & Schneider, 1977) and that the automaticity need not lie in direct cue-behavior associations. For instance, making coffee may be a very efficient behavior and will be executed from start to finish

once initiated, but the actor is fully aware of the process and its initiation may still require attentional control. Instead of a direct cue-behavior association, the cue may automatically prompt a verbal decision process which then leads to behavior. The flexibility that is required in many everyday situations may lie in the verbal decision and that decision could then trigger an automatized behavior. In this way, self-directed language can integrate flexibility and efficiency. This perspective is in line with hierarchical accounts of the relation between goals and habits (Dezfouli & Balleine, 2012, 2013). In this thesis, we propose a process that guides action in situations in which behavior is neither entirely guided by deliberate effortful processing nor entirely guided by environmental cues. In other words, we are interested in situations where behavior is well-trained and efficient, but retains some flexibility.

Verbal thought could be one intervening mechanism when behavior is somewhat but not fully rigid. Specifically, we propose that asking oneself questions can modulate repeated action. Self-talk, defined as an ongoing dialogue with oneself (Alderson-Day & Fernyhough, 2015; Dolcos, Wilson, Sánchez, Zell, & Albarracín, 2016), has been linked to sports performance (Hardy, 2006), responses to stress (Kross et al., 2014), and task performance (Dolcos & Albarracín, 2014). People also strategically use self-talk to break existing habits (Quinn, Pascoe, Wood, & Neal, 2010). In this thesis, we linked different self-talk questions to decision making. When making a choice, self-asking questions like “Should I do this?” or “Which one should I choose?” is likely natural. These questions are parallel to those described in the situated inference model (Loersch & Payne, 2011): In this model, it is assumed that a given situation affords a certain question which is then answered using accessible information. For example, meeting a new person could afford the question “What kind of person is this?”, and if a previous prime has made kindness-related information accessible, this will likely be used to answer the

question. In our work, we assume that habitual behavior can similarly serve as accessible information in answering self-posed questions. If an action has been repeated sufficiently often to establish a response tendency, the most likely answer to “Which one should I choose?” is the option that has been chosen before. This prediction implies that such a question makes repetition of previous behaviors likely. If people’s normal thought processes resemble this sequence, then experimentally presenting such a natural question during a decision-making process should either have no effect: It’s identical to what people would do anyway. Alternatively, it could facilitate the performance of repeated behaviors: If the cue-behavior association is not yet strong enough to lead to perfect repetition by itself, adding such an affirmative question might reinforce the tendency to choose a previously chosen option, as evidenced by professional musicians and athletes who report using verbal self-instructions to improve their performance of even highly learned behaviors (Geeves et al., 2014; Jenkins, 2007; Toner & Moran, 2014). In contrast, a question like “Which one should I not choose?” that is less likely to spring to mind naturally and invites rethinking a prior choice might disrupt the performance of the repeated behavior. In this thesis, we want to examine if and how different questions can modulate the performance of repeated responses.

Experiment 1[1]

The goal of this study was to provide evidence for the effect of questions on repeated behavior. We chose a one-factor within-subjects design and compared an affirmative question, "Which one should I choose?", that we assumed to be something that people would naturally ask themselves in a choice situation, with a corresponding negative question, "Which one should I not choose?", and with a no-question condition.

Method

Forty-three participants were recruited from the paid community participant pool of the University of Pennsylvania Wharton School and received $5 in compensation. The sample included 27 women (63%) and 16 men (37%) and participants were between 18 and 65 years old, $M = 25.49$, $SD = 11.44$. Participants reported their race as follows: 33% Caucasian, 30% Asian, 26% African American, 9% Hispanic or Latino, and 2% selected the "other" category. The majority of participants (86%) reported that English was their first language. To reduce the effect of trials where participants did not consider their response at all, considered it in too much detail, or took too long because they were momentarily not paying attention, trials with reaction times under 200 ms or over 3500 ms were excluded, which resulted in the removal of 7% of all trials. In all three experiments, results did not change when all trials were included.

We developed a choice task to train repeated behavior in the lab. The task had four steps (see Figure 1): First, participants saw pictures of three identical doors labeled 'left', 'center', and

[1] The first two experiments were conducted by Christopher Jones and Dolores Albarracín. The third experiment and all reported analyses of the three studies were conducted by Sophie Lohmann.

'right'. Pressing the 'l', 'c', or 'r' keys led to choosing one of the doors, revealing the picture of an animal. There were four sets of doors, each distinguished by a different background color, resulting in a total of 12 animal pictures. In the first phase, participants saw each set of doors 10 times and their task was to learn the locations of the pictures. For example, for the doors with the orange background, there was a picture of a dog behind the left door, a picture of a cat behind the center door, and a picture of a hamster behind the right door.

In the second phase, participants chose their favorite picture for each set of doors. For example, someone might prefer and thus select the orange door with the hamster picture behind the right door. In the third step (training phase), participants saw the same pictures of doors and were trained to choose their favorite pictures over and over again. For example, whenever they saw the orange set of doors, the study would not continue until they had chosen the right door which was hiding the hamster. They saw each set of doors 30 times, resulting in 120 trials. In the fourth step (test phase), participants were informed that they were now free to choose any doors they wanted to. Before each set of doors, they saw one of three additional screens (within-subjects) for 2000 ms: A blank screen that served as no-question baseline, the question "Which one <u>should I</u> choose?" as an affirmative question, or "Which one <u>should I not</u> choose?" as a negative question. Next, one of the four sets of doors appeared and participants had to choose one of the doors. Participants were asked to read the questions as if they were saying them to themselves and to use them in decision making: "If you see a question, please ask it to yourself to make your choice. It is of the **utmost** importance that you read these questions as if talking to yourself as they appear." These instructions were designed to make participants pay attention and to ensure that they would parallel the experience of self-talk. Each combination of question type and set of doors was presented 10 times, resulting in 120 trials. Finally, participants answered

questions on their gender, race and ethnicity, participation in previous experiments, age, native language and English skills, and problems that occurred. The experiment was programmed in MediaLab and DirectRT (Jarvis, 2010a, 2010b). We recorded how quickly participants responded and how often they continued to choose their favorite pictures in the test phase (proportion of repeated behavior). For all three studies, we report all data exclusions (if any), all manipulations, and all measures in the studies (Simmons, Nelson, & Simonsohn, 2012).

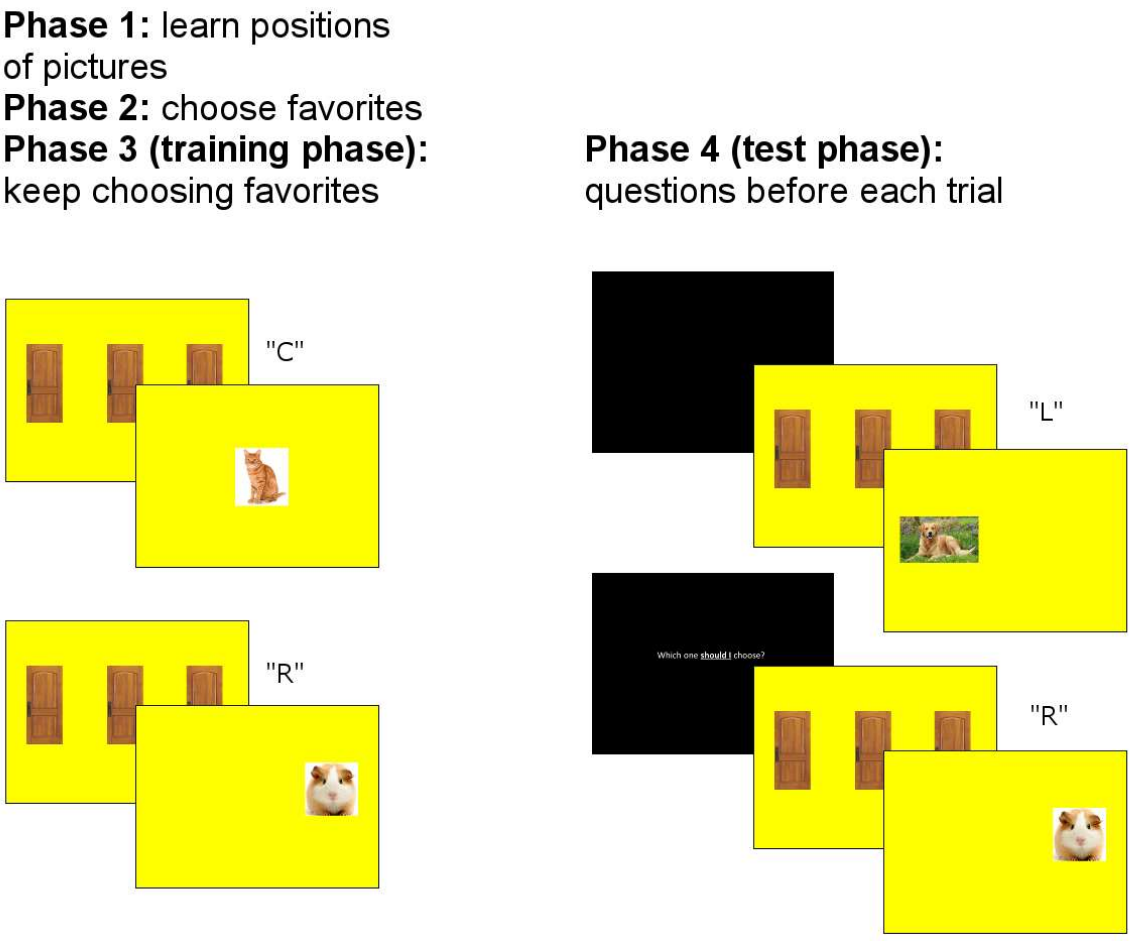

Figure 1. Schematic representation of the door choice paradigm. The key assignment for choosing pictures was "L" for the left door, "C" for the center door, and "R" for the right door. The examples show the no-question condition and the affirmative-question condition.

Results

The proportion of repeated action in the no question condition was 49% (see Table 1). This level is above the chance mark of 33% but is well below 100%. Thus, this level of repetition is indicative of a response tendency that is pronounced enough to guide behavior but not strong enough to completely restrain deviations from the response pattern. In other words, this pattern represents exactly the case of moderate habitual control that we expected to be optimal for self-talk to guide behavior.

Table 1

Average Proportions of Repeated Behavior in All Studies, with Standard Deviations in Parentheses.

Question	Experiment 1	Experiment 2	Experiment 3	
			Free choice	Repetition instruction
None	.49 (.50)	.59 (.49)	.46 (.50)	.90 (.30)
Affirmative	.62 (.49)	.71 (.45)	.52 (.50)	.89 (.31)
Negative	.19 (.40)	.30 (.46)	.33 (.47)	.84 (.36)
Irrelevant	–	.47 (.50)	.43 (.49)	.88 (.33)

A multi-level logit regression with repeated choice (0: other picture than the previously chosen favorite, 1: favorite picture) as the dependent variable and random intercepts for participants resulted in a main effect of question, $\chi^2(2) = 684.65$, $p < .001$. The model coefficients adjusted for multiple testing showed that the affirmative question was associated with higher levels of repeated action than the no-question baseline, $OR = 1.72$, 95% CI [1.46, 2.03], $p < .001$, see Table 1. We calculated the difference between how often participants repeated their actions in the affirmative condition and in the no-question condition for each

participant separately and found that this score was bigger than zero for 79% of participants. That means that the effect we observed across participants was also present in 79% of individual participants and not just driven by a small number of individuals. In contrast, the negative question was associated with lower levels of repeated action than the baseline, $OR = 0.23$, 95% CI [0.19, 0.28], $p < .001$. Analyzing the difference score between repeated action in the negative versus no-question conditions, we found that all but four participants showed this effect (91%).

Discussion

These results indicated that different questions can influence degree of continuity in repeated action. In particular, reading the affirmative question "Which one should I choose?" made people more likely to repeat their past behavior. This finding is in line with the hypothesis that when the cue-behavior association in the baseline condition is not highly fixed, the cue-behavior association plus the question facilitates behavior repetition more than the cue-behavior association by itself. Also, as expected, the negative question "Which one should I not choose?" disrupted the repetition of previous behavior to below-chance levels. It could, however, be argued that the training phase was too short to truly start the shift from effortful to automatic responding in any of the conditions. In addition, this experiment only compared two questions and thus allows only limited conclusions about what kinds of questions are effective. To address these issues, we conducted the next study.[2]

[2] We conducted an additional study (not presented here) that pretested the effect of cognitive load during the training phase on results in the test phase ($n = 21$ cognitive load, $n = 23$ control). This manipulation of cognitive load, however, did not have an effect and results were inconclusive. However, consistent with our results in Experiment 1, across both groups we found that the affirmative question significantly facilitated the performance of repeated behavior compared to the no-question baseline, whereas the negative question significantly disrupted it.

Experiment 2

Method

In Experiment 2 we examined whether the observed effects could be obtained with any question regardless of content. This study had a one-factor within-subjects design (no question, affirmative question, negative question, irrelevant question). The newly introduced irrelevant question was "What should I have for dinner?". We recruited $N = 55$ participants from the paid community participant pool of the University of Pennsylvania Wharton School participated in exchange for $5. Thirty-three participants were female (60%) and 22 were male (40%); 40% were Asian, 27% Caucasian, 20% African American, 9% Hispanic or Latino, and 4% selected the "other" category. Participants' ages ranged from 18 to 49, $M = 22.76$, $SD = 5.47$. Eighty-two percent of participants reported that English was their first language. Trials with reaction times below 200 ms or above 3500 ms were excluded, which resulted in the removal of 6% of all trials.

To ensure that all participants gained a degree of automaticity in responding, we increased the number of trials in the training phase from 30 trials (as in Experiment 1) to 50 trials per set of doors and included a short breather break in the middle. To keep the sessions short despite this increase in trials, we did not include the blue set of doors used in Experiment 1. Further, we added a fixation prompt after each question to ensure that our previous results could not just be explained by the questions drawing more visual attention to the doors than the blank screen in the no-question condition. Otherwise, the design was identical to Experiment 1.

Results

A multi-level logit regression with repeated choice (0: other picture than the previously chosen favorite, 1: favorite picture) as the dependent variable and random intercepts for participants resulted in a main effect of question, $\chi^2(2) = 698.14$, $p < .001$. All contrasts were

corrected for multiple testing. The effects found in the first two studies were replicated: People repeated their choices more often under the affirmative question than under the no-question baseline, $OR = 1.80$, 95% CI [1.48, 2.20], $p < .001$, and 64% of individual participants showed this effect. Under the negative question, people repeated their choices less often, $OR = 0.22$, 95% CI [0.18, 0.27], $p < .001$, 71% of individual participants showed this effect. The irrelevant question was also associated with below-baseline levels of repeated action, $OR = 0.55$, 95% CI [0.46, 0.67], $p < .001$, but this effect was comparatively small and not nearly as pronounced as that of the negative question. The irrelevant and negative questions were statistically different, $OR = 2.52$, 95% CI [2.04, 3.10], $p < .001$.

Discussion

As in the previous study, the affirmative question was associated with higher levels of repeated action than no question at all. Again, the negative question was associated with lower levels of repeated action compared to no question at all. Responses to the newly introduced irrelevant question did not mimic the responses of either the affirmative or the negative question, suggesting that the questions need to be thematically related to the choice to have the identified effects. In both studies presented so far, participants were explicitly instructed to use the questions in making their choice. It is thus possible that the obtained results are an artifact of these directions. Therefore, we removed these directions in the next study. In addition, we wanted to test the hypothesis that the self-talk questions are most effective when behavior is well-trained, but still flexible, by manipulating the flexibility that the instructions allowed.

Experiment 3

Method

The next experiment varied the instructional set that participants received. We hypothesized that people who were free to choose any picture they wanted to would be affected by the questions as in the previous studies, whereas people who were instructed to keep repeating their choices would not be as affected by the questions. Participants were recruited from the psychology participant pool at the University of Illinois at Urbana-Champaign and received course credits as compensation. We aimed to collect 60 participants per condition and scheduled more than that because we wanted to run full sessions. We ended up with $N = 125$ for whom both information on their favorites and on their test phase choices was available, 60 participants in the free-choice condition and 65 participants in the instructed repetition condition. The final sample included 73% women and 27% men and was comprised of young adults from 18 to 25, $M =$ 19.46 years, $SD = 1.33$. The race and ethnicity composition was as follows: 58.4% Asian, 28% White, 7.2% Latino, Latina or Hispanic, 2.4% Black, 1.6% Middle Eastern, North African, or Arab American, and 2.4% other. The majority of respondents reported self-talking only in English or in English and other languages (66%; only $n = 59$ participants answered this question) and 52.8% of participants reported that English was their first language.

We manipulated instructional set by restricting participants' freedom of choice: For the group with free-choice instructions the experiment was the same as in the previous study and they were explicitly told that they were free to choose any door they wanted to in the test phase. For the group with repetition instructions the test phase instructions stated that "Your task is to continue choosing the door that you picked in Part 2. ... Remember that you are supposed to keep choosing the doors that you picked as your preferred ones." This study had a 2 (free-choice

instruction, repetition instruction; between-subjects) x 4 (no question, affirmative question, negative question, irrelevant question; within-subjects) design. Participants were randomly assigned to the between-subject condition.

In addition, participants were no longer instructed to use the questions in making their choice. We wanted to test if the effects we observed in the first two studies were truly effects of simply reading the questions, and not just of being instructed to say them to oneself or of demand effects. Instead of reading instructions to ask the question as if talking to themselves, participants in this experiment read the following:

> Please use these questions as a fixation point (i.e., look at them). Typically, researchers just use an "x" as a fixation point, but we want to test a theory saying that different stimuli may improve attention. We vary the formats and trials to sample different conditions under which learning occurs. The questions are taken from another study and are not related to your task in this study. ... Remember, the questions are just there to focus your visual attention, they are not directions.

The key assignment was changed from "l", "c", and "r" for left, center, and right doors to "1", "2", and "3" to reflect the order of the doors on the keyboard so that participants could respond more efficiently. The irrelevant question was changed to "What should I do this weekend?" to assess the effect of a different irrelevant question and because of comments that combining "What should I have for dinner?" with various animals like cats, dolphins, or geckos could be seen as slightly macabre. A suspicion check and items on how difficult and confusing the study was and the language that participants usually rely on for self-talk were added to the demographics section. We included the blue doors again and did not include the fixation prompt. All other procedures were identical to Experiment 2. Trials on which participants took less than

200 ms or longer than 3500 ms to respond were excluded, which removed 5% of all trials. One trial on which a participant made no response at all was excluded.

Results

A multi-level logit regression with repeated choice (0: other picture than the previously chosen favorite, 1: favorite picture) as the dependent variable and participant as a random grouping factor for the intercept resulted in a main effect of question, $\chi^2(3) = 185.66$, $p < .001$, and a main effect of condition, $\chi^2(1) = 83.25$, $p < .001$. These main effects were qualified by a question x condition interaction, $\chi^2(3) = 13.00$, $p = .005$. Contrasts adjusted for multiple tests revealed that in the free-choice condition, the affirmative question was associated with higher levels of repeated action than the no-question baseline, $OR = 1.34$, 95% CI [1.14, 1.57], $p < .001$, whereas the negative question was associated with lower levels of repeated action than the baseline, $OR = 0.53$, 95% CI [0.45, 0.63], $p < .001$. In the repetition instruction condition, the difference between the affirmative question and the baseline was not significant, $OR = 0.87$, 95% CI [0.67, 1.13], $p = .526$. In contrast, the negative question was still associated with lower levels of repeated action than the baseline, $OR = 0.48$, 95% CI [0.38, 0.62], $p < .001$.

Next, we evaluated how many individual participants showed the expected effects. In the free-choice condition, 63% of participants chose their favorite pictures less often in the negative question than in the no question condition and 55% chose their favorite pictures less often in the no question condition than in the affirmative question condition. In the repetition instruction condition, 42% of participants chose their favorite pictures less often in the negative question than in the no question condition, but only 31% chose their favorite pictures more often in the affirmative question condition than in the no question condition.

Discussion

When participants were free to choose, the results are the same as in the first three studies: The affirmative question has a facilitating effect on the performance of repeated action and the negative question has a disrupting effect. The same effect of the negative question occurred when people's choices were constrained by the instructions. In contrast, the facilitating effect of the affirmative question disappeared in that condition. It should be noted that the base rate in the repetition instruction condition was very high and might have led to a ceiling effect. In conclusion, self-talk questions may have the strongest effect when people's choice actually matters as opposed to there being one objectively correct answer and when the base rate of behavior repetition is not too high to start with.

General Discussion

Across three experiments, we showed that exposing people to questions influences their choices in repeated situations. These effects are strongest when the questions are relevant to the choice at hand. These effects occur whether the questions are presented as instructions to be followed or as distractors to be ignored. Finally, we showed that the effects of the questions are diminished when personal freedom of deliberation is reduced by the instructions.

Showing people the affirmative question "Which one should I choose?" on a screen made them more likely to repeat past behavior; showing them the question "Which one should I not choose?" made people less likely to repeat past behavior. There are several possible reasons for this pattern. First, participants may have interpreted the questions as instructions telling them to indicate to the experimenter which one they should or should not choose. To discourage participants from this interpretation, in Experiment 3 we informed participants that the questions were not instructions and that they should not, in fact, use them. This change had no effect on how the questions affected behavior. Second, merely reading the word "not" in the negative question might have functioned as a stop signal, making participants stop the execution of the most salient behavior. The more complex sentence structure may have been irrelevant. This, however, would not explain why the affirmative question increased rates of repeated behavior compared to baseline. Third, participants may have adopted the questions as a form of self-talk merely by reading them. This self-talk would then influence decision making. Relevant questions that people may not typically ask themselves could draw the decision making process away from its usual route. This would explain the lower rate of repeated behavior in the negative question condition. The third explanation can be tested more directly in future research: Observing people's natural self-talk in choice situations and experimentally manipulating which questions

are natural in a given situation will give more insight in how posing oneself questions affects behavior.

The effectiveness of self-talk questions seems to depend on the base rate of behavior repetition and on how much behavior variability is allowed by the circumstances. Repeated behavior happens on a continuum ranging from completely flexible choices that are guided by deliberate decisions to completely rigid habits that are guided by context cues. In Experiment 3, instructions that allowed less flexibility reduced the impact of the questions compared to instructions in a control condition and in the first three experiments, which allowed participants freedom of choice. Future work can test this hypothesis further by comparing habits of differing strengths: Given a stable context, a behavior that has been repeated more often should fall higher on the deliberate choice-habit continuum and be less affected by the questions than the same behavior that has been practiced less often.

We have proposed self-talk questions as a mechanism that can guide action when behavior has been practiced often enough to be considered a weak habit but still retains flexibility. The results of our studies show that depending on the type of question, this self-talk can increase or decrease the proportion of habitual action as long as the questions are relevant to the decision-making process. This intermediate verbal step between cues and behavior thus allows people to retain flexibility in repeated action.

References

Aarts, H., & Dijksterhuis, A. (2000). Habits as knowledge structures: Automaticity in goal-directed behavior. *Journal of Personality and Social Psychology*, *78*(1), 53–63. http://doi.org/10.1037//0022-3514.78.1.53

Alderson-Day, B., & Fernyhough, C. (2015). Inner speech: Development, cognitive functions, phenomenology, and neurobiology. *Psychological Bulletin*, *141*(5), 931–965. http://doi.org/10.1037/bul0000021

Bargh, J. A. (1994). The four horsemen of automaticity: Awareness, intention, efficiency, and control in social cognition. In R. S. Wyer & T. K. Srull (Eds.), *Handbook of social cognition* (2nd ed., pp. 1–40). Hillsdale, NJ: Erlbaum.

Dezfouli, A., & Balleine, B. W. (2012). Habits, action sequences and reinforcement learning. *European Journal of Neuroscience*, *35*(7), 1036–1051. http://doi.org/10.1111/j.1460-9568.2012.08050.x

Dezfouli, A., & Balleine, B. W. (2013). Actions, action sequences and habits: Evidence that goal-directed and habitual action control are hierarchically organized. *PLoS Computational Biology*, *9*(12). http://doi.org/10.1371/journal.pcbi.1003364

Dolcos, S., & Albarracín, D. (2014). The inner speech of behavioral regulation: Intentions and task performance strengthen when you talk to yourself as a You. *European Journal of Social Psychology*, *44*(6), 636–642. http://doi.org/10.1002/ejsp.2048

Dolcos, S., Wilson, K., Sánchez, F., Zell, E., & Albarracín, D. (2016). *Talking to myself for self-regulation: Meta-analysis and qualitative review of the experimental evidence on the behavioral effects of self-talk.* Manuscript submitted for publication.

Geeves, A., McIlwain, D. J. F., Sutton, J., & Christensen, W. (2014). To think or not to think:

The apparent paradox of expert skill in music performance. *Educational Philosophy and Theory*, *46*(6), 674–691. http://doi.org/10.1080/00131857.2013.779214

Hardy, J. (2006). Speaking clearly: A critical review of the self-talk literature. *Psychology of Sport and Exercise*, *7*(1), 81–97. http://doi.org/10.1016/j.psychsport.2005.04.002

Jarvis, B. G. (2010a). DirectRT [Computer software]. New York, NY: Empirisoft Corporation.

Jarvis, B. G. (2010b). MediaLab [Computer software]. New York, NY: Empirisoft Corporation.

Jenkins, S. (2007). The use of swing keys by elite tournament professional golfers. *International Journal of Sports Science and Coaching*, *2*(Supplement 1), 199–229. http://doi.org/10.1260/174795407789705460

Kross, E., Bruehlman-Senecal, E., Park, J., Burson, A., Dougherty, A., Shablack, H., … Ayduk, O. (2014). Self-talk as a regulatory mechanism: How you do it matters. *Journal of Personality and Social Psychology*, *106*(2), 304–324. http://doi.org/10.1037/a0035173

Loersch, C., & Payne, B. K. (2011). The situated inference model: An integrative account of the effects of primes on perception, behavior, and motivation. *Perspectives on Psychological Science*, *6*(3), 234–252. http://doi.org/10.1177/1745691611406921

Moors, A., & Houwer, J. De. (2006). Automaticity: A theoretical and conceptual analysis. *Psychological Bulletin*, *132*(2), 297–326. http://doi.org/10.1037/0033-2909.132.2.297

Neal, D. T., Wood, W., Labrecque, J. S., & Lally, P. (2012). How do habits guide behavior? Perceived and actual triggers of habits in daily life. *Journal of Experimental Social Psychology*, *48*(2), 492–498. http://doi.org/10.1016/j.jesp.2011.10.011

Quinn, J. M., Pascoe, A., Wood, W., & Neal, D. T. (2010). Can't control yourself? Monitor those bad habits. *Personality and Social Psychology Bulletin*, *36*(4), 499–511. http://doi.org/10.1177/0146167209360665

Shiffrin, R. M., & Schneider, W. (1977). Controlled and automatic human information processing: II. Perceptual learning, automatic attending and a general theory. *Psychological Review*, *84*(2), 127–190. http://doi.org/10.1037/0033-295X.84.2.127

Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2012). A 21 word solution. *SPSP Dialogue*, 1–4. http://doi.org/10.2139/ssrn.2160588

Toner, J., & Moran, A. (2014). In praise of conscious awareness: A new framework for the investigation of "continuous improvement" in expert athletes. *Frontiers in Psychology*, *5*. http://doi.org/10.3389/fpsyg.2014.00769

Tricomi, E., Balleine, B. W., & O'Doherty, J. P. (2009). A specific role for posterior dorsolateral striatum in human habit learning. *European Journal of Neuroscience*, *29*(11), 2225–2232. http://doi.org/10.1111/j.1460-9568.2009.06796.x

Verplanken, B., & Orbell, S. (2003). Reflections on past behavior: A self-report index of habit strength. *Journal of Applied Social Psychology*, *33*(6), 1313–1330. http://doi.org/10.1111/j.1559-1816.2003.tb01951.x

Wood, W., & Neal, D. T. (2007). A new look at habits and the habit-goal interface. *Psychological Review*, *114*(4), 843–863. http://doi.org/10.1037/0033-295X.114.4.843

Wood, W., & Rünger, D. (2016). Psychology of habit. *Annual Review of Psychology*, *67*(1), 289–314. http://doi.org/10.1146/annurev-psych-122414-033417

Yin, H. H., & Knowlton, B. J. (2006). The role of the basal ganglia in habit formation. *Nature Reviews Neuroscience*, *7*(6), 464–476. http://doi.org/10.1038/nrn1919